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LIGHTNING.

THERE are indications that we may anticipate severe electrical disturbances during the coming summer. The winter has been unusually long and severe. Abnormal weather has occurred over most parts of the globe. Reports of severe thunder-storms reach us from the Cape and the antipodes. Exceptional conditions of this kind abroad usually presage similar conditions in England. "Coming events cast their shadows before." But whether the coming summer be above or below the average in lightning accidents, we are none the less bound to call attention to the fearful apathy and gross carelessness evinced in protecting buildings from atmospheric electrical discharges.

During two severe storms in England, in June, 1872, there were ten deaths and fifteen cases of injury to human beings; sixty houses struck, and fifteen burnt down; and twenty-three horses or cattle, and ninety-nine sheep, killed. Those accidents that are not recorded are innumerable. In large towns damage to property is more frequent than destruction of human life, but in the open country destruction of life is perhaps more frequent than destruction of property, unless we except trees, which are ruined in thousands every year, and unfortunately—from their size and growth—the finest suffer.

Lightning protection is therefore not only a necessity, but it is a source of satisfaction and comfort. It is difficult to comprehend the reasons why it is not more largely adopted. It is not its inutility—for the beneficial effect of lightning-conductors amongst our buildings and our shipping is incontestible. It is not its expense—for a house can be protected for a less sum of money than is required to bed out a parterre. It is not its difficulty—for any skilled workman or energetic landlord can do it with ease.

Dr. Mann, the President of the Meteorological Society, has done good service in reading an exhaustive and able paper on the subject before the Society of Arts, and an admirable notice was given of it in the *Times*. Dr. Mann has supplemented this notice with an excellent letter to the leading journal on the precautions to be taken, especially with the tall zinc tubes now so largely used for chimney-tops. Mr. Preece had previously called attention, in the *Times*, to the danger of chimneys, lined as they are with soot, filled with ascending currents of heated air and smoke, and terminated in grates, acting as lightning-conductors. If all such chimney-pots be connected with the water-pipes by galvanised iron ropes, and if all these pipes make good earth, a house is as safe from lightning as a collier in a mine.

All lightning-protectors should be constructed on proper scientific principles, and we have published in our columns many valuable papers on the subject. The great desiderata to be urged are—the employment of perfectly continuous metallic ropes or rods, the use of good earths, and the termination of the conductors in the air in points. A great fact to be remembered is, that joints, and earths, and points deteriorate, and lose their efficiency: they therefore require frequent examination and frequent renewal. Lightning-conductors require annual inspection and careful overhauling.

It is needless to point out to telegraphists the necessity of a good earth, for they all know that their circuits are unworkable without them; but it is lamentable to see the condition of the earths to the lightning-protectors of the steeples of some of our cathedrals and churches. The splendid new spire of Llandaff cathedral is positively in a dangerous condition from this cause. Nine out of every ten churches are in the same condition. Earth-wires are plunged into the interior of cisterns; they are leaded into stones; they are bedded in dry sand. One was carefully put into a glass bottle buried in the dry earth; another was coiled carefully into the interior of a wooden pail, in the basement floor of the house it was meant to protect. Every case of the inefficiency of lightning-protectors that has been examined has been proved to be due to the existence of such gross ignorance of the commonest principles of electrical science as is evidenced by the above cases.

The country is now overrun with telegraphs. Telegraphists are to be found everywhere. There is no difficulty in securing the advice and assistance of skilled men, and our churchwardens and church dignitaries would do well to call such experience to their aid. It is better to lock the stable door before the steed is stolen.

POST-OFFICE TELEGRAPHS.—Statement showing the total number of messages forwarded from Postal Telegraph Stations in the United Kingdom during the week ended the 1st May, 1875, and during the corresponding week of 1874:—1875, 394,518; 1874, 377,849; increase in the week of 1875 on that of 1874, 16,669.—Week ended 8th May, 1875, and corresponding week of 1874:—1875, 402,502; 1874, 375,870; increase in the week of 1875 on that of 1874, 26,632.

THE Manager of the Direct Spanish Telegraph Company, Limited, informs us that the average time occupied in the transmission of telegrams between Madrid and England, *via* Santander, during April, was 2 hours and 57 minutes (including transmission over Spanish land-lines).

CENTRAL TELEGRAPH STATIONS.

THE great commercial capitals of the world, London and New York, have, within a very short period, been provided with Central Telegraph Offices which for extent and completeness are unequalled elsewhere. The Central Telegraph Station in St. Martin's-le-Grand, and the new offices of the Western Union Telegraph Company in Broadway, New York, may be regarded as evidences of an amount of progress such as has attended few institutions in our time. Less than thirty years ago the "system" of the late Electric Telegraph Company—or, to speak more correctly, the telegraphic system of the United Kingdom—consisted of a line to Nine Elms, and a small office at 334, Strand. Similarly, in 1846, a single wire was erected to an obscure office beneath the express offices at No. 16, Wall Street, New York, and two wires from Washington terminated in a small room over the Ferry-house in Jersey city, where three clerks easily—and not very continuously—performed the whole telegraphic business of the city of New York. We need not trace the progress of the Electric Telegraph Company eastwards until it acquired extensive offices,—first, in Founders' Court, Lothbury, and subsequently in Telegraph Street, Moorgate Street. Nor need we do more than simply mention the British and Irish Magnetic Telegraph Company, with its offices in Threadneedle Street, and the United Kingdom Telegraph Company, located in Gresham House. All three were eventually housed in the premises built by the Electric Company in Telegraph Street, and thence the next move was to the new Post-Office in St. Martin's-le-Grand. This event occurred on the 17th of January, 1874; and little more than a year afterwards—viz., on the 1st of February last—the Great American Telegraph Company moved to its new premises in Broadway, New York.

The American structure has been erected at a cost of more than two million dollars, and a considerable portion of this amount has been subscribed in England—chiefly in London, we believe. It is built of brick and granite, in what, with some latitude, may be designated as the French Renaissance style, the main idea in its construction being to reduce in appearance—by the proportions and the arrangement of the details—the great height of the building, as compared with its width or front. The building is said to be fire-proof throughout, wood having only been used for the doors, window-sashes, and the wainscoting. Most people are familiar with the appearance of our new Post-Office buildings in St. Martin's-le-Grand. Many regard them as being wholly devoted to telegraph purposes; but it should be explained that only the top floor, the basement, and one or two rooms on the intervening floors are so occupied. The building of the Western Union Telegraph Company, in New York, extends to the height of no fewer than ten separate floors, and is mainly occupied by the various offices of the Company; but it is with the operating rooms, situated on the seventh floor, just as it is with the instrument galleries in St. Martin's-le-Grand, that we are mainly concerned in speaking of both as central telegraph stations. The American room is 145 ft. long, 70 ft. wide, and 23 ft. high, or about the size of the central gallery in St. Martin's-le-Grand. This gallery, supplemented by the side wings, and forming a space somewhat resembling the letter H, has a superficial area of not less than 20,000 feet; so that the American room is not much more than half the size of our own. The instrument tables do not extend to more than 500 ft. in length in New York, while those at St. Martin's-le-Grand extend to 2800 ft., or more than ½ a mile. In America, where the system of "sound" telegraphy prevails to a large extent, the tables are cut into short lengths, each separated into four compartments, so as to isolate the operators from each other and to confine the sound as much as possible. Here, owing to the variety of systems employed and the extensive use of automatic instruments, the tables are of considerable length, and are open throughout. In the Western Union Company's new office less than 200 instruments of all kinds are employed, including 149 Morse instruments, 15 sets of duplex apparatus, and 6 of Phelps's printing instruments. In St. Martin's-le-Grand the total number of instruments exceeds 450, and includes 195 Morse printers, 122 single needle instruments, 65 sets of duplex apparatus, 53 sets of Wheatstone's automatic instruments, and 18 of other sorts. The switch or test board of the American office is arranged for the distribution of 300 wires; that in our own Post-Office building is arranged to accommodate 800 circuits, and if need be the provision can be extended to 1000 lines without difficulty. Batteries, which are to the telegraph what the boiler is to the locomotive, are always an object of anxiety in planning a large telegraph office. They cannot well be situated in the instrument room on account of their peculiar construction and their continual wants, and yet they should not be too far away from it. In this respect the New York Office, where the batteries are stored in a room immediately underneath the operating room, has a decided advantage over the London Office, where several floors intervene between the instrument galleries and the battery room. In extent, however, the two departments are as widely different as are the arrangements in the respective instrument rooms. In the Western Union Company's Office provision is only made for a *maximum* power of less than 17,000 cells, while the number of cells actually in use does not exceed 7000. At St. Martin's-le-Grand 50,000 cells can readily be accommodated in the large room in the basement of the building set apart as a battery store, while at the present moment not fewer than 23,000 cells are actually in use. Not far short of 2 miles of shelving have been constructed in this room for the reception of batteries, and a perfect avalanche of wires descends from the instrument galleries above, in order to transmit the motive power to the 450 instruments, whose wants are as numerous as they are varied and unceasing. Including these cattery connections, and other connections between different points in the instrument galleries, not less than 260 miles of gutta-percha covered wire are buried under the floors of the building in St. Martin's-le-Grand.

We have been struck with the small extent of the pneumatic system in the great Telegraph-office of New York. Apparently the system is confined to the building itself, and does not extend beyond the receiving and delivery departments. A single 20-horse power engine is all the motive power required in connection with this department, the remaining machinery—situated in the basement of

the building—being required in connection with the elevators, and for heating purposes. The pneumatic system at St. Martin's-le-Grand is one of the great features of the building. No fewer than twenty-five separate tubes communicate with out-stations in the Metropolitan district, ranging from Fenchurch Street and Tower Hill in the east, to Temple Bar and Charing Cross in the west. These tubes extend to a length of nearly 18 miles, and are worked outwards by pressure and inwards by vacuum. In addition to these outlying tubes there are twelve tubes within the building itself, used for blowing messages between one part of the instrument galleries and another. So rapidly is this effected that an average of four seconds only is occupied by the "carrier" in making the journey across the room, or from one wing to another, as the case may be. The motive power by which the tubes are worked exists in the basement of the building, in the shape of three steam-engines, each of 50-horse power. Two of these are constantly employed in pumping air into, or sucking it out of, huge mains carried up the outer walls of the building, and connected with the tubes upstairs. The third is at rest, ready for any emergency, or to take the place of that whose turn for rest next comes round. The engine-room resembles nothing so much as the hold of a great steam-ship, and, from the peculiarly interesting character of the machinery, it is a great source of attraction to the numerous visitors to the Central Telegraph Office. Four boilers, each of 50-horse power, and fitted with Vigars's patent stokers, occupy a corresponding position of the basement to that occupied by the engines; and an Artesian well is in process of sinking, which, it is hoped, will supply not only the boilers, but the whole of the building, with water.

It only remains to notice the *personnel* of the two great telegraph offices of the world, and to sum up the amount of business transacted in each. Less than 300 persons, including 75 female clerks, are employed by the Western Union Company in its central office in New York, and the average number of messages disposed of daily, exclusive of news messages, is stated to be 24,000. Allowing for the news service, which is stated to amount to about 90,000 words daily, an average of 27,000 messages a day would be attained. Here, in London, as many as 1200 persons, including 700 females, are employed in the Central Telegraph Station. The number of ordinary commercial messages dealt with in a day, allowing for such as have to be re-transmitted—*i.e.*, received on one wire and sent out on another—is upwards of 50,000, and taking the news service, exclusive of special wires, at 500,000 words a day, which is a fair average, during the Parliamentary Session a total of more than 70,000 average messages would be reached. The news service is a feature to which very special importance is attached at our Central Telegraph Station. Special wires, known as the "Express Circuits," are set apart for the service, and the Wheatstone system—which, while it economises the wires, largely increases the Staff—is almost exclusively employed. At night, when the great bulk of the news work comes in, as many as forty wires are exclusively occupied in the transmission of matter for the Press throughout the United Kingdom. Nineteen of these wires are leased out to certain provincial newspapers in England, Scotland, and Ireland. The remaining twenty-one are worked to the principal towns of the kingdom, and, taking their united capacity, it would be found that—on a fairly busy night—as many as half a million of words, equal to 250 closely-printed columns of the *Times*, would be disposed of. Besides the clerks employed at the newspaper offices in working the special wires, as many as 200 clerks are employed each night at the Central Telegraph Station between 8 P.M.—when the female Staff leaves duty—and midnight, when the bulk of the news work has generally been disposed of. From midnight until 2 A.M. more than 100 clerks are usually employed; and at no time of the night is the number less than 70. Scarcely, indeed, has the night service of news been completed when the morning service begins, and it would be almost impossible to select any hour out of the twenty-four when Press matter—either in the shape of markets, exchanges, or general news, Reuter, sporting, or Parliamentary—is not passing over the wires.

If the telegraphic system is not yet perfect, it will be granted, at least, that its development thus far has been singularly rapid, and there is, perhaps, no better evidence of this than in the great central offices of London and New York. After all, these immense establishments are but the growth of little more than a quarter of a century; for, as we have seen, it is less than thirty years since a small room in West Strand and another in Wall Street represented the head-quarters of the telegraph systems of the Old World and the New.

THE VOLTAIC BATTERY.

A Course of Six Lectures,

By Dr. JOHN HALL GLADSTONE, F.R.S.,

Fullerian Professor of Chemistry, Royal Institution.

Delivered at the Royal Institution of Great Britain.—Christmas, 1874-5.

Lecture V.

Through the kindness of Prof. Adams, Prof. Armstrong, Mr. Murray, and other friends, there have been lent to me various original forms of galvanic batteries. Some of these I introduced in my last lecture, but there were others which I could not refer to then; and I have thought it well, therefore, to have them put together and placed in the ante-room, upon the table there. You will be interested in looking at them after the lecture. There is, however, one old instrument which I have not put in the ante-room, but have brought upon the table here, and that is this rough-looking electrical apparatus. Now there is not much to admire in its appearance; its interest consists in its history. This is the very electrical machine which Faraday made with his own hands when he was apprenticed to a bookbinder. You may recollect that he was born of honest, good, but very poor parents, and that he was apprenticed early in life. He read some of the books which his master bound or sold, and among them was a copy of the "Encyclopædia Britannica." He read the article "Electricity" in it, and this gave him a great desire to have an electrical machine of his own. Of course, as to buying one, that was out of the question, and so he thought he would make one if he could. And, as I find by the

papers of Sir James South which I have been quite recently looking over, he procured, first of all, a couple of glass vials, for which he gave the amount of sevenpence, and tried to make an electrical machine with them, but failed. He then thought that he must have a real glass cylinder, but even at glass-house price this would cost 4s. 6d.—and how was he to get 4s. 6d.? The summit of his ambition was at that time to get a glass cylinder. Well, at last he saved up 2s., and induced his master, Mr. Riebau, to advance him the other 2s. 6d., to be taken off his wages as time went on. Then he went and bought this cylinder, and he and his father and brother set to work upon it. His father was a journeyman blacksmith, and he made the iron axle that you see there, and passed it through. It is fastened on with corks rather cleverly. And then Faraday dissolved some sealing-wax, which, he said afterwards, was the first chemical experiment he ever performed; and here is the result. You see the sealing-wax with which he insulated the cylinder from the cork. After having placed the sealing-wax—perhaps not very artistically—inside, he covered over the ends of the cylinder with sealing-wax, in order to hide the imperfections of his workmanship. Then as to the stand. There happened to be in his master's cellar an old broken mahogany table, and Faraday got hold of this, cut it into pieces, and made this stand and supports: while a few pence were given to some one to turn the other necessary portions of the apparatus. A piece of silk was obtained, and this rubber was made, and then his brother formed this simple but very effective spring—a brass spring, which keeps the rubber pressing against the cylinder. This prime conductor was also made, which is, as you see, of very simple materials. Unfortunately, it is incomplete; it ought to have a glass stand, but that has disappeared, and so it has been rigged up with this sort of jury-stand at present, in order that it may be in its right position. Then with a handle, which has also disappeared, he was able to turn this cylinder round, and produce sparks and the ordinary phenomena of frictional electricity. Here is an iron clamp, made by his father I have no doubt, by which this machine might be fastened to a table. I thought this would be interesting to you, not only from its connection with the great Prof. Faraday, but also because some of you might like to make your own apparatus; and here you have before you an example from one of the greatest philosophers.

I do not want to say much about frictional electricity, for we are talking about electricity of another kind; but all these electricities are linked together. They are a brotherhood or sisterhood of forces, or rather, they are the same force manifesting itself in different forms. Frictional electricity will give us, as you know, a spark; and as I have brought here a very old and very venerable instrument, I have also brought one of the latest novelties in electricity. [Exhibiting an American electrical torch.] By moving this knob I can separate these two discs, and in doing so I can produce electricity which manifests itself by a spark. The spark ought to appear in this little cup and ignite the gas. [A jet of gas was ignited several times by the use of the electrical torch.] That pretty little contrivance illustrates the fact that the force is produced by two opposing plates, and by just separating them we are able to get the manifestation of electricity.

Here we have an apparatus—one which is employed for practical purposes—in which two metals are joined together, as in the voltaic pile; but there is no chemical action. They are simply heated at their point of junction. There is a gas flame impinging on the junction of these sets of two metals. The heat acts the same part as the chemical force; it keeps up an electrical difference between the hot and the cold ends, thus allowing of the formation of a current, and I dare say we shall be able to see that it will deflect this magnetic needle just as one of our galvanic cells did. There goes the needle; it flies off just as it would if this apparatus had been a voltaic battery.

Now we can produce electricity also by other means, and one of those most frequently employed is the rotation of magnets. You know very well that a galvanic battery will make a magnet. You have seen that on a large scale. On the large magnet of this Institution we were able to hold very large weights, to build up our bridge of nails, and to make iron filings go into all those beautiful lines of force between the poles which were shown in the first lecture. Well, if we take a magnet we are able from it to produce electricity again,—in fact, an electric current. Many pieces of apparatus have been arranged with that view; but the one I have upon the table is called Gramme's machine. It consists of two sets of magnets, but they are joined together by iron bars, so that, in point of fact, the two north poles are joined, and the bar becomes the north pole of the magnet. The lower ones become the south pole of the magnet. Between these there is an endless coil of wire twisted round and round certain little bars. These little bars communicate with the axle, and if I set it rotating I can get, through this magnet, currents formed in these wires. The current is reversed from the one side of the wires to the other side, so that the one side becomes north and the other south; but it passes gradually from north to south, and the two sides are constantly in opposite conditions. We are able to collect the power by means of these little bars of copper, and carry it off as a stream wherever we please. I will just carry it to this large bell. [An electric bell was rung by means of the Gramme current.] This Gramme's machine will produce a spark. The spark is extremely feeble, and I will not attempt to show it to you all. It can be seen by those who are near at hand. This is only a model of the Gramme's machine as now manufactured. To Sir Charles Wheatstone and Mr. Sabine I am indebted for this. The electric light which is exhibited on the top of the Houses of Parliament during the Session is ignited by means of a Gramme's machine, and they are being prepared now very considerably for electrotyping purposes. I speak of this magneto-electric apparatus more especially, because the current we obtain by means of it is very like the voltaic current. It is not a succession of sparks, but a continuous flow, so that from a magnet we get a current which is almost identical with the current which we get from the voltaic battery.

You will see that in these illustrations which I have given you we have a contact of two bodies. In the electrical machine, the mechanical motion by which we separate them is converted into the

electrical force. In the apparatus which I showed you just now it is heat which keeps up the force. In Gramme's machine we have magnetism and mechanical action producing and sustaining the force. In the galvanic battery we have chemical force initiating it, or, at any rate, keeping it up. In all these cases, therefore, we have various forces which produce very much the same effects. We can produce a spark; we can produce a shock to the nervous system; and we can produce light, heat, chemical decomposition, and so on, by these various means. I do not say that all these forces are identical, but they are all—as I said just now—sisters; they are all related closely one to the other; they are forms of force which are convertible one into the other. The quantity of force does not change, but the form of the force does change, and we may imagine that they are modifications of the first prime force, whatever that may be. Whether we shall ever know more about this prime force I do not know, or whether we should simply consider it as the manifestation of the will of that Great Spirit who is near us all, and "in whom we live and move and have our being."

But there is a difference between the electricity we get from the machine, or the electricity we get from this thermal apparatus, and the electricity we get from our voltaic batteries. No doubt they differ from one another; but then the electricity we get from a galvanic battery is not always the same. We can produce either a very slow, quiet, strong action, or a sudden brisk action, from the galvanic battery. Here is a Grove battery. At present it is arranged in such a way that there is a platinum plate, then there is the zinc joined with another platinum, and so on. So that it goes alternately zinc, platinum, zinc, platinum, and the power accumulates as it goes on through the liquid in this way. Thus we get a voltaic battery of great power, and we can so arrange ten cells, or a hundred cells if we please; or we can arrange—as in the large battery of Davy, or that of Mr. De la Rue—a thousand cells one after the other, and in this way we can get an accumulation of power. I will not go into the mathematics of the question now; but, at any rate, it does happen that we are able to pile up this electromotive force from these different cells in such a way that we get what is called an "intensity" arrangement. We get an exceedingly powerful forward action, and this "intensity" is capable of overcoming serious resistance by going through long spaces of water, bad conducting earth, or coke, or anything of that sort, and by flying across air in sparks; so that it resembles more the electricity that we get from the frictional machine, or the electricity with which Nature furnishes us in that great electrical machine—the thunder-cloud. I am not going into the physical part of the question. I believe Prof. Tyndall intends to exhibit some of these things which are upon the table now, and to enter more fully into the matter, in the course which he has announced. But I should like just to draw your attention to this—that we can have this electricity in different conditions even in the battery; that we can arrange it, as I said just now, accumulating the force so as to get what we call "intensity," and to get this powerful spark; or, on the other hand, we may arrange it so as to produce "quantity." If we take a battery like this,—if we were to take two, or ten, or a hundred, or a thousand cells, and join the platinum to the platinum, and join the zinc to the zinc, we should get only the same effect as from an immensely large zinc plate and an immensely large platinum plate, like the large cell which I put before you in the first lecture. We should get an immense quantity, but little intensity. The electricity would not pass over any space, or any great resistance, and yet the quantity would be enormous. We could do a great deal of electrotyping with it, for instance, and the quantity of electricity we get from this arrangement—even from such a small Grove's cell—is enormous. I have on the table, exhibiting itself quietly, a larger quantity of electricity, I believe, than is displayed in a thunderstorm, and yet it is perfectly under our management here, and I have not the slightest hesitation in handling it. But if this power were disposed in another way, and, instead of appearing as electricity of quantity, it was flowing as electricity of tension, I should be afraid to take hold of the wires.

(To be continued.)

EXPERIMENTS TO ASCERTAIN THE CAUSE OF STRATIFICATION IN ELECTRICAL DISCHARGES IN VACUO.*

By WARREN DE LA RUE, HUGO W. MÜLLER, and WILLIAM SPOTTISWOODE.

Some results obtained in working with a chloride of silver battery of 1080 cells, in connection with vacuum-tubes, appear to be of sufficient interest to induce us to communicate them to the Society, in anticipation of the more detailed account of an investigation which is now being prosecuted, and which it is intended to continue shortly with a battery of 5000 cells, and possibly with a far greater number.

The battery used up till now consists of 1080 cells, each being formed of a glass tube 6 inches (15·23 c.m.) long and ¾ of an inch (1·9 c.m.) internal diameter: these are closed with a vulcanised rubber stopper (cork), perforated excentrically to permit the insertion of a zinc rod, carefully amalgamated, $\frac{3}{16}$ (0·48 c.m.) of an inch in diameter, and 4·5 inches (11·43 c.m.) long. The other element consists of a flattened silver wire, passing by the side of the cork to the bottom of the tube, and covered—at the upper part above the chloride of silver, and until it passes the stopper—with thin sheet gutta-percha, for insulation, and to protect it from the action of the sulphur in the vulcanised corks: these wires are $\frac{1}{16}$ of an inch (0·16 c.m.) broad and 8 inches (20·32 c.m.) long. In the bottom of the tube is placed 225·25 grains (14·59 grms.) chloride of silver in powder—this constitutes the electrolyte; above the chloride of silver is poured a solution of common salt, containing 25 grms. chloride of sodium to 1 litre (1752 grains to 1 gallon) of water, to within about 1 inch (2·54 c.m.) of the cork. The connection between adjoining cells is made by passing a short piece of india-rubber tube over the zinc rod of one cell, and drawing the silver wire of the next cell through it so as to press against the zinc. The closing of the cells by means of a cork prevents the evaporation of water, and not only avoids this serious inconvenience, but also contributes to the effectiveness of the insulation. The tubes are

* A Paper read before the Royal Society.

grouped in twenties, in a sort of test-tube rack, having four short ebonite feet, and the whole placed in a cabinet 2 ft. 7 ins. (78·74 c.m.) high, 2 ft. 7 ins. wide, and 2 ft. 7 ins. deep, the top being covered with ebonite to facilitate working with the apparatus, which is thus placed on it as an insulated table.

The electromotive force of the battery, as compared with a Daniell's (gravity) battery, was found to be as 1·03 to 1,* its internal resistance 70 ohms per cell; and it evolved 0·214 c.c. (0·0131 cub. in.) mixed gas per minute when passed through a mixture of 1 volume of sulphuric acid and 8 volumes of water, in a voltameter having a resistance of 11 ohms. The striking-distance of 1080 element between copper wire terminals, one turned to a point, the other to a flat surface, in air, is $\frac{1}{25}$ inch (0·096 m.m.) to $\frac{1}{250}$ inch (0·1 m.m.). The greatest distance through which the battery current would pass continuously *in vacuo* was 12 inches (30·48 c.m.) between the terminals in a carbonic acid residual vacuum. This battery has been working since the early part of November, 1874, with practically a constant electromotive force.

Besides 2000 more cells like those just described, we are putting together 2000 cells with the chloride of silver in the form of rods, which are cast on the flattened silver wires, as in a battery described by De la Rue and Müller,† but in other respects similar to the battery above described, the glass tubes being, however, somewhat larger in diameter: the rods of chloride of silver are enclosed in tubes open at the top and bottom, and formed of vegetable parchment, the object of these vegetable parchment cases being to prevent contact between the zinc and chloride of silver rods. The internal resistance of batteries so constructed is only from 2 to 3 ohms per cell, according to the distance of the zinc and chloride of silver rods, and they evolve from 3 to 4·5 c.c. (0·18 to 0·27 cub. inch) per minute, in a voltameter having a resistance of 11 ohms. Their action is remarkably constant.

(To be continued).

Notes.

THE *Faraday* has succeeded in recovering the Direct United States cable, and exchanging signals with Ireland. No official announcement has been made, and consequently there has been a good deal of movement in Atlantic Telegraph shares. It is much to be regretted that information so important to the public should not be issued, and some authoritative announcement made.

At a meeting of the Great Northern Telegraph Company, at Copenhagen, on the 28th ult., the total dividend for the year was announced as being at the rate of 7 per cent, and £12,114 14s. 1d. was added to the reserve fund.

The directors of the German Union Telegraph and Trust Company have issued their Report for the year ending the 1st of May last. The available balance amounts to £12,096 3s. 7d., out of which an interim dividend of 5s. 9d. per share was distributed in January last, and a further payment is now recommended of 7s. per share, making a total distribution of 12s. 9d. per share, or at the rate of £6 7s. 6d. per cent per annum.

A meeting of the Eastern Telegraph Company is summoned for the purpose of sanctioning the acquisition of a convention with the Italian Government respecting a telegraph cable between the Island of Sardinia and the Italian continent.

An interesting experiment has just been carried out at the Indo-European Company's Office, in Telegraph Street, in order to test the accuracy of a new chronometer, made by Messrs. Barraud and Lund, of Cornhill, which was carried out by Capt. Sartorius to Teheran. The line was joined through to Teheran, and time signals sent, thus enabling Teheran to receive Greenwich mean time. The result of the trial, which was most successful, showed that the watch was slow by two seconds.

It is with regret we notice the sudden death of Admiral Sherard Osborn, C.B., who for many years was the Managing Director of the Telegraph Construction and Maintenance Company. To his administrative capacity and his business talents a great amount of the success of that Company must be due. He had retired from the management of that Company some short time since to resume his naval career. It was during his management and under his direction that the greatest works were carried out.

Recently a man fell from the roof of the Pomona Gardens, near Manchester; and fortunately for him his fall was broken by the telegraph wires on the Bridgewater Canal, otherwise he must have been killed, or at all events lamed for life.

An interesting question came before the Queen's Bench as to the rights of *employés* in the telegraph department of railway companies to compensation under the Telegraph Act, 1868. That statute, which enabled the Postmaster-General to acquire, work, and maintain electric telegraphs, authorised him to purchase the undertakings of different companies, and the 8th section of it provided for the compensation of officers or clerks of the companies and undertakings so taken over by the gift of an appointment of equal value, or where no appointment was made by the award of an annuity. In the case before the Court the applicant had been in the employment of the Electric and International Company, and at the same time held the post of telegraph superintendent of two railway companies

* Compared with a Daniell's battery, in which the zinc is immersed in dilute sulphuric acid in a porous cell, its electromotive force is about 3 per cent less than the Daniell.

† "Journal of the Chemical Society," 2nd series, vol. vi., p. 488.

‡ "Comptes Rendus," 1868, p. 794.

In respect of his claim for loss of employment under the Electric, his right to compensation was admitted, but the Postmaster-General disputed any liability in respect of the other employment, and the application was for a *mandamus* to issue from the Queen's Bench to the Postmaster-General to assess the compensation in respect of these losses of services. The Court refused the application on the ground that there was an obvious distinction between the telegraph clerks of telegraph companies and those of railway companies, and that there was no provision in the Act for compensating the railway officials. The distinction lay in the fact that as the telegraph companies were constituted solely for the purpose of sending the messages of the public, the taking over of these undertakings practically extinguished the companies, and that therefore it was only fair that clerks who had been employed by them should be provided with some other occupation or receive money compensation for their loss of service. With the railway companies this was different. The wires and posts remained the property of the companies; they still used and worked them for their own purposes and to manage their own traffic; and so their clerks were not necessarily deprived of employment by the operation of the Act.

One of our young men, of a statistical turn of mind, has discovered, by a careful computation, that if we estimate that each of the sixty young ladies in the City department wears on an average twenty hairpins (and for a *very* curly headed one this is a fearfully small allowance), it would require 600 feet of No. 20 steel wire to equip the whole force,—enough to build an average amateur telegraph line. An ordinary hairpin picked up in the elevator gave a measured resistance of 0·002 ohms. As the magnetic attraction is in all cases inversely as the square of the resistance, it would appear—from theoretical considerations—that the ladies wearing the fewest hairpins would be the most attractive; but experience fails to confirm the absolute infallibility of this law, as many singular anomalies present themselves. A long series of careful observations upon curly-headed girls have fully verified the truth of Dub's law, that "the attraction is proportionate to the square of the number of convolutions," and this fact has served to restore that confidence in the result of scientific study which had previously been in some measure dispelled.—*The Telegrapher.*

Trial is to be made at Portsmouth of a system of signalling by bugle, which has been introduced by Capt. Bamber, Royal Marines, for use in fogs or at night when no signal lantern is available. The plan consists mainly in an adaptation of Morse's telegraphic alphabet to bugle calls, the "long" and "short" being represented by different notes.

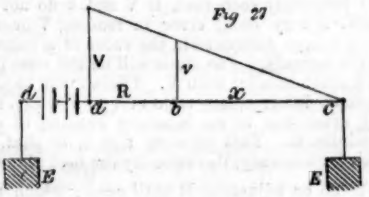
Students' Column.

Resistances and their Measurement. By H. R. Kempe.

(Continued from vol. ii., p. 396.)

XVI. *The Measurement of Resistances by Potential.*—There are two ways of measuring resistances by potential:—1st, by noting the potentials at two or more points in a known resistance with which the unknown resistance is in connection, and by calculation, from the potentials so obtained and the known resistance, deducing the value required. Also by measuring the potential of a battery which is shunted with the unknown resistance, and then reproducing this potential by an adjustable resistance used in the place of the unknown resistance. 2nd, by noting the rate at which a charged condenser, of a known capacity, discharges itself through the unknown resistance, and calculating the result from a formula.

Fig 27



If we connect a battery to a resistance, R+x, as shown by Fig. 27, the potential of the battery falls regularly along the resistance, being full at a and zero at c. The same would be the case if c and d were connected together instead of being put to earth. By similar triangles—

$$V : v :: R+x : x,$$

or—

$$x = R\frac{v}{V-v},$$

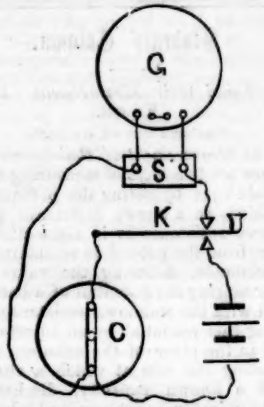
V being the potential at a, and v the potential at b. So that, if R is a known resistance, we can—by noting the potentials at a and b—determine the value of x.

The potentials are best measured by means of a condenser. To do this we should join up our condenser and galvanometer as shown by Fig. 24, which we have before given, the only difference being that the terminals which are represented as being in connection with a battery would, instead thereof, be connected to the points a and d or c for determining V, and to b and d or c for determining v. The condenser discharges in the two cases give V and v. Thus, for example, if R were 1000 ohms, and V were 300° and v 200°, then—

$$x = 1000\,\frac{200^\circ}{300^\circ - 200^\circ} = 2000 \text{ ohms.}$$

If $b\,c$ were a portion of a cable making full earth at c, we should by this method determine the position of the fault.

The accuracy with which a resistance can be measured by this method is limited by the accuracy with which the discharge deflections representing V and v can be read. If we cannot be certain of

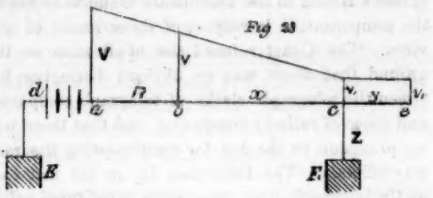


V or v to within 1 per cent, still less can we be sure of the accuracy of x within 1 per cent. It will be clearly seen that, if V and v do not differ much, a very small error in reading V or v will make a large difference in the value of x calculated by the formula. The same will be the case if v is very much smaller than V. There must, therefore, be some intermediate ratio of v to V which makes any error due to an incorrect reading of v or V a minimum. This ratio is 1 to 2, so that, if we wish for accuracy, theoretically the best plan would be to go on adjusting R until $v=\frac{V}{2}$, which makes $x=R$. There is, however, a practical difficulty in doing this, for we cannot first note V and then adjust R until $V=\frac{V}{2}$, for the alteration in R will have changed V also. For example, if at starting we found V=300°, and we then adjusted R until v=150°, or one-half 300°, we should probably find that on re-measuring V it would be no longer 300°, but some deflection greater or less than 300°, according as R was increased or diminished. We could, of course, by continual re-adjustment, at last arrive at a value of R which makes $v=\frac{V}{2}$, but this might involve a considerable expenditure of time; so the best proceeding would be to adjust R by large variations until we get V within, say, 10° of the value of $\frac{V}{2}$, and having noted carefully what the exact values are, to calculate x from the formula.

If, instead of introducing the unknown resistance x, and a known resistance R, between the points a and c, and measuring the potentials at a and b, we have only the resistance x, we can determine its value by simply noting V, and then inserting an adjustable resistance in the place of x, and altering it until we obtain the potential V at a, as at first, when of course $x=R$.

Supposing a cable had a fault which did not make full earth, then the potential would not fall to zero at that point, but would have a value depending upon the resistance of the fault. The potential, however, at the fault would be the same as the tension at the further end of the cable, provided that end were insulated. If we can determine the value of this potential we can readily detect the position of the fault.

Fig 23



Let $a\,e$ be the cable which has a fault at c, the end of the cable at e being insulated. Then—

$$V-v_1 : v-v_1 :: R+v : x;$$

therefore—

$$x(V-v_1)=(R+x)\,(v-v_1);$$

therefore—

$$x=R\,\frac{v-v_1}{V-v}.$$

There would be no difficulty in making this test if the three potentials could be all made in common measure. This could be done if both ends of the cable were at hand; but when a cable is laid this would be impossible, as the potentials at the two ends must be measured with two different galvanometers, and no two galvanometers give exactly the same deflection for the same strength of current, and there is no means of determining what the ratio of one deflection is to the other with the same strength of current. If a satisfactory standard of electromotive force existed there would be no difficulty in doing this, as the discharge deflections from standard condensers charged from standard electromotive forces taken on the two galvanometers would indicate at once the relative value of their deflections.

If the cable is sound when the laying is commenced, a battery put on at one end would charge it to the same potential throughout, when the further end is insulated. Supposing the charging battery to be on board the ship, the electricians there would charge a condenser from the cable and note the discharge deflection obtained. A similar observation would be made at the shore end, and the deflection obtained noted, and the result telegraphed to the ship, which is thus put in possession of the relative value of the deflections of the two galvanometers. During the laying of the 1866 Atlantic cable these deflections were noted by the shore every five minutes, and the result telegraphed to the ship. Supposing the shore obtained a discharge deflection of 300°, whilst the ship obtained one of 200°, when the cable was perfect, then the ship knows that 1° deflection on the shore galvanometer corresponds to $\frac{200°}{300°}$ obtained on its own galvanometer: all it has to do, therefore, is to multiply the results given by the shore by this number, to obtain all the results in common measure. An example will illustrate how a test would be applied in practice. Suppose the cable to have a conductor resistance of 800 ohms. The potential at a ob-

tained by the ship is represented by 200° discharge deflection; the shore telegraphs his result as 300°. Now, suppose a fault to occur, the ship will observe that his discharge deflection has sunk, and he notes its value. Let it be 170° (V). He also notes the potential at b, which we will suppose to be 70° (v). The shore telegraphs (which he will be able to do, as the cable is not completely broken down) that his potential is 30°. To convert this to common measure the ship multiplies this number by $\frac{200°}{300°}$, which gives v_1 as 20°. Let R be 1000. Then from the formula we get—

$$x = 1000\,\frac{70° - 20°}{170° - 70°} = 500,$$

showing that the fault is 500 ohms distant from the ship end of the cable. If the length of the cable was, say, 80 miles,—that is, it has a resistance of $\frac{800}{80}$, or 10 ohms per mile,—then the distance of the fault would be $\frac{500}{10}$, or 50 miles from the ship end of the cable.

If a fault, making partial earth, appears in a laid cable, we could localise its position in the following manner:—First, let the further end of the cable be put to earth; note the potential at the nearer end. Next, have the end of the cable insulated, and again note the potential at the nearer end. If we now reproduce these potentials by means of an adjustable resistance, we can find what the resistances were which gave the two potentials in question.

If we call x the resistance up to the fault, y the resistance beyond the fault, and z the resistance of the fault itself, then, in the first case,—

$$r = x + \frac{y\,z}{y+z};$$

second,—

$$r_1 = x + z,$$

and also—

$$L = x + y,$$

where L = the conductivity resistance of the line when perfect. This value is always taken when the cable is first laid.

Then by the formula we gave in Article XII.—

$$x = r - \sqrt{r(r - r_1) + L(r_1 - r)}.$$

The advantage of this method of measuring by potentials would be the rapidity with which the two measurements could be taken. If directions were given that the end of the cable was to be put to earth at a certain time, and then at another given time to be insulated, the first discharge deflection would be taken a few seconds before the time for insulating, and then directly the end is insulated the second discharge reading would be made, and, the deflections being reproduced with the adjustable resistance, the value of x calculated. When the two measurements are made thus rapidly, there would be far less chance of the fault changing its resistance than when the test is made by the ordinary bridge method of measurement, in which each measurement takes a considerable time. The only interval necessary between the two readings in the potential method would be that required to allow the galvanometer needle to return to rest before taking the second discharge.

(To be continued.)

Correspondence.

EARTH-BORING FOR TELEGRAPH POLES.

To the Editor of the Telegraphic Journal.

Sir,—In the hope that it may be interesting to many of your readers, I beg that you will allow me a space in your columns to reply to the arguments used in the discussion following the reading of the paper, before the Society of Telegraph Engineers, by Mr. Gavey, on this subject (reported in your Journal of January 1st). Many of the objections raised to the adoption of this method of fixing poles have arisen from—

The temporary awkwardness which invariably marks the initiation of any new implement or apparatus.

The disposition of ordinary labourers to oppose any innovation which involves the exercise of a little extra physical and mental exertion, until the temporary awkwardness disappears and gives place to that "free and easy" use of the new tool which characterises their accustomed style.

A quicker perception in discovering or anticipating difficulties in a "new" creation than in recognising the more salient points of practical advantage, which can only become apparent in use.

Among the objections raised in the discussion there are, as I hope to be able to show, some that have no real existence, and others that do not outlive the first experiences of the men, while those few which alone may be considered to have any substantial form are, in practice, reduced to such small consequence as to be unworthy of regard when the manifold advantages of the system are properly considered.

Mr. Von Truenfeld observes that there is a certain difficulty in ramming the earth round the pole, which is greatly increased when the pole happens not to be in the centre of the hole. I venture to say that this is quite a mistake: it is proved beyond question that the speedy and successful ramming of a pole in a bored hole is one of the greatest points of advantage,—perhaps the most advantageous of all. When a crooked pole has to be pressed out of its concentricity to obtain a generally upright pitch, I have always found the operation of punning to be rather facilitated: this is somewhat opposed to the experience of Mr. Truenfeld, who adds that in wet clay the difficulties in the way of punning are very great in holes bored, and these are not likely to occur when the holes are dug in the ordinary way. In bored holes, the space to be filled in being so small, our men use the driest surface loam for ramming or otherwise to mix with the wet clay, and thus a sound punning is effected. I have found no difficulty in ramming a pole firm in a bored hole in any soil, but with a hole dug in the ordinary way it is practically impossible to ram a pole firm in wet—or even soft—clay; and this I believe to be very generally known.

I have lately had some experience in putting up lines in South America, over a difficult country, and where it was impossible to obtain any but very inferior labour, and I am able to state that the "borers" were eminently successful. A supply of picks and shovels had been provided, but these were never used, the men preferring the borers to pick and shovel; at the same time it must be admitted that if left to their own selection of tools they would not have used either, but have scraped out the holes with the aid of a piece of iron and a cocoa-nut shell, while working in an easy reclining position.

I did not find that the number of tools to be carried was at all increased; on the contrary, the appliances were fewer in number and more convenient in form,—consisting of one borer, a punner bar, and broad grafting tool, for two men who made the holes and fixed the poles themselves. (The poles were of hard wood, from 20 to 22 feet long by 4 inches minimum

diameter at top, cut in the forest along the line of route.)

I would here observe that Mr. Truenfeld had misunderstood Mr. Gavey with regard to the use of shear-legs and the necessity for carrying a pick and shovel.

The line which formed the subject of reference and figures in Mr. Gavey's paper was an exceptionally heavy one, for accommodating a great number of wires, the weight of each pole varying from 5¼ to 10¼ cwts., with top fittings to upwards of 50 lbs. The line referred to by Mr. Truenfeld, being for military purposes, would be a light one, and therefore the circumstances were very different.

To use shear-legs for raising small poles which two or three men may carry would be rather ridiculous, and to upraise very heavy poles, with their extra top weight, without the economic aid of light and handy shear-legs (except in certain cases), is, in my humble opinion and experience, equally absurd.

In stating that there are circumstances under which it becomes necessary to carry also a pick and a shovel, the writer, as I understood, had in view those lines in this country which are erected along public and private roads, where at times poles have to be fixed in awkward and difficult places, altogether different to having the open country or a clear line, as in by far the majority of cases; but notwithstanding these occasional restrictions in this country as to the position of poles, it has been found practicable, and also substantially economical, to have no pickaxes on the work under any circumstances.

I take the liberty here to observe that the borers exhibited were not made previous to 1870, and although having the appearance, at first sight, of the ordinary screw-pile or screw-auger, they are quite different, both in form and action, as will be seen upon a closer inspection.

Mr. Graves raises a more practical objection in the labour attendant on the use of the "borers," and I do not find any other difficulty suggested by that gentleman's remarks except that the heavy borers cannot be worked against a wall or fence; but, as Mr. Gavey states, a light borer, with a short handle or ratchet, is highly successful in working in hedge-banks or other difficult places.

In six months' working on public roads, some years ago, in different parts of three counties, it was found that 80 per cent of the holes were bored, this being before the light spoon-borers were used in exceptional places.

Mr. Graves is scarcely correct in taking exception to the amount of ground to be traversed in using the borers, and the damage that might in this way be done to crops.

It rarely happens that poles are erected where crops are growing, and the treading of the men in using a borer is as nothing compared to the excavation of a hole, which at any rate is 4 feet long by 2 feet wide at the top, besides the large superficial area that is covered with the earth thrown out from such a pit, which in shovelling back again causes the grass or crops to be cut away.

The additional labour in using the borer at first is a point of some importance, and in my opinion is the only feature worthy the serious observations of scientific and practical men. Here we have the whole of the difficulty in the true reason that the men avoid using it, while in casting about for excuses for preferring the old method they raise a lot of other objections which are frivolous.

It is certain that if the men, as a rule, "took to the borers" there would be very little to be said against them. It is also a matter of fact that where the men have been disposed to use them they have done so with such extraordinary success as to make the ordinary method appear an anomaly.

Many years' experience and observation in the use of these implements have convinced me that whenever the men find that they must use the borers, they immediately and instinctively discover how to do so without distressing themselves, and, after getting accustomed to it, prefer the new method. On the other hand, when allowed to do so, they will (to use Mr. Graves's own words) instinctively cling to the spade. This is not very surprising if we consider the matter in its true light, for it is simply the repetition of the old story on the introduction of machinery.

Mr. Graves seems to have given the Spanish spoon a fair trial, but the borers do not appear to have got beyond experimental tests.

The "Spanish spoon" is not a "circular metal disc," as stated in your abridged report on Mr. Gavey's paper, but is only a "third section of a circle" (as in the original paper), and therefore raises the earth, which is previously broken up with a bar, in very small quantities. I need not add to Mr. Gavey's remarks on this point, beyond pointing out that holes made in this manner are largest where they require to be small, and *vice versa*, and to this fact is due most of the difficulty—mentioned by Mr. Graves—in raising the poles: the holes are invariably very much larger at top than at the bottom, sloping downwards on all sides like an inverted cone, and the pole upon being raised finds a footing anywhere, in consequence of which the bank or side of the hole is crushed down from top to bottom. When rammed, the pole in such holes is little, if any, firmer than in those made with pick and shovel.

From Mr. Burton's experience, which coincides with that of Mr. Truenfeld, it would appear that the principal obstacles to the use of the borer are due to the irregular shape of the timber in certain parts, the falling of the earth into the hole, and the serious difficulty in ramming,—points which, being set forth as practical disadvantages, are calculated to create in the minds of persons who have not used these implements an impression which is not quite correct.

Theoretically, a crooked pole put in a hole, not much larger than itself, which is straight, appears contradictory; while practically, it is a very small matter of detail, scarcely noticed.

By shaking or pressing a crooked pole, after it is in the hole, in any particular direction, a few times, the leverage of the pole causes an indent in the side of the hole, which allows the pole to come upright, and also solidifies the bank to the pressure of the wires in cases where an angle occurs.

If the pole is exceedingly crooked the chisel end of the bar is used (after boring the required depth) to slice down a portion of one side of the hole, as required, the earth being removed again with the borer: this is a very insignificant operation, which suggests itself to the men at the time, and forms not the slightest obstacle.

The falling of earth is entirely obviated by placing the punner bar in the hole, point down, against the side opposite to the butt of the pole, which, upon being raised, foots against it and slides down. With very heavy timber, a man puts a shovel there to catch the foot of the pole upon its being raised, and, using it as a lever, causes the pole to slip down immediately. I may observe that, in dug holes, the men use a plank for this purpose when the timber is at all heavy, but all these arrangements are made more to facilitate the raising of the pole than to prevent the falling of earth, which is too slight to be of consequence, unless arising from some very exceptional cause. It must be evident to all who have seen poles erected in bored holes that the pole lodges, or foots, but once,—that when upraised against this footing it drops perpendicularly to the bottom of the hole with considerable force, and thereby crushes itself firmly into the earth.

In reply to Major Malcolm, I beg to state, as a fact, that the V-shaped opening has never in my experience been jammed with stones, nor is there any probability of this occurring. The action with small is precisely the same as with large borers; stones are repeatedly brought up on top of the plate which are "twice the size" of the V-shaped opening: there is no lodgment in this opening for the stone, which is pressed partly into the bank or side of the hole, while the plate passes under it. This, I may point out, is due to the peculiar action of the cutter plate, which is not that of a "screw," but of a "circular plough."

Mr. Culley deals with the subject in a very practical manner, which encourages the hope that the *vis inertiæ* will be overcome in time, as it has been with very many other new appliances. In America it appears, from Mr. Culley's remarks, that the pick and shovel are never used. It is also worthy of note in that gentleman's observations that, in clay, two men bored a hole 5½ feet in thirteen minutes: according to Mr. Gavey's figures (which appear to me to be rather within the mark) it would take one man two hours to do this with pick and shovel,—in addition to which must be considered the filling in, or punning, which in the latter case would occupy three men at least one hour, while in the bored hole two men would accomplish it easily in six or seven minutes.

Replying to Mr. Goldstone, who has found that the borers work successfully on railways while on the flat, I would observe that I have used them repeatedly on embankments and sides of cuttings with success, the difficulty being removed by shovelling the earth from the "upper side" of the spot intended for the pole to the "lower side," thus forming a platform for the men to walk round in turning the borer: this is in hard ground, but in light soil or tipping a light spoon borer may be used by one person only without moving round: this is a great advantage, for, as Mr. Goldstone states, it is very desirable in such cases to disturb the ground as little as possible.

In digging a pit for a pole on an embankment it will be seen that the upper side is always cut away to a great extent before the hole is really formed; therefore it is not extravagant to cut away a smaller amount to facilitate the using of the borer in those cases.

I feel assured that all these points will be readily and quickly mastered by the men themselves whenever the system is once for all adopted and insisted upon.

In concluding this rather long letter, I wish to make a few remarks on the very important points raised in the discussion concerning what are called A poles, in order to show that the opinions there expressed—although formed upon scientific theory—are not borne out in practice.

After no inconsiderable experience with A poles, and having made the experiment, I find that an A pole structure, without a cross bar, or sill-piece, fixed in bored holes, and simply punned in a proper manner, is more effective than a similar structure with the cross bar attached in the large pit dug to receive it in the ordinary way.

The importance of this subject, in an economic point of view, is somewhat startling, for—in addition to the extra cost of the 8-feet cross bar, fitted with strong bolts—the cost of erecting the structure in the "usual manner" is from five to six times greater than with bored holes.

It is well known that A poles generally give way, more or less, to the strain of the wires, and this is invariably allowed for in fixing, by giving the structure a slight pitch in the opposite direction to the strain. Obviously this movement, however slight, has the effect of reducing the tension, and lessens the pressure on the pole by slackening the wires.

In bored holes the structure does not give to the strain of the wires, nor afterwards: this is a result better explained by pointing out the different action that takes place in forcibly uplifting a pole out of a bored hole and out of one made with pick and shovel.

The resistance of a pole to being uplifted is not (as I understand Mr. Bell to have stated) according to the friction of the earth against the sides of the pole, because it is quite impossible to lift a pole out of the hole (bored) after it has been even moderately rammed in. The resistance is in proportion to the weight of earth displaced in lifting, added to the natural cohesion of the particular soil.

In a bored hole it will be found impossible to pull a pole out of its punning, or with its punning out of the space of the original hole. The solid earth will be broken and disturbed at an angle of 45° from the lower centre point of the pole, in every direction upwards. With a pole dug in the ordinary way it is widely different; a large portion of earth having been disturbed, its natural cohesion is destroyed, and is not recovered by ramming: even if compressed into less space, it will not regain its former cohesive power for some years. The space punned is small at the bottom, but on one side of the pole widens upwards in the direction of the angle of pressure, thus offering a yielding or weak side, which gives out in proportion to and direction of the pressure.

In reply to another observation of Mr. Bell, I wish to observe that the depression of 1 foot of an A pole, in bored holes, involves the movement of both poles horizontally in the direction of the strain, which is opposed by the resistance of the natural bank of solid undisturbed earth, which is also intact *between* the two poles.

I venture to hope that this question may form a subject for future experiment.—I am, &c.,

W. A. Marshall.

Electrical Science in English and Foreign Journals.

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxx., No. 13. April 5, 1875.

A Remarkable Case of Magnetisation.—J. Jamin.—Galileo, in 1607, stated that a stone-magnet in his possession "was so powerful that, on approaching the point of a scimitar to a distance equal to the thickness of a silver piastre, it could not be held back." Also, it was found that "the same pole attracted and repelled the same piece of iron. At a distance of at least 4 or 5 finger-breadths the iron was attracted, but at 1 finger's-breadth distance it was repelled. If the piece of iron was placed on a table, and the magnet put very near it, the iron fled before the magnet as it was made to advance; but if the magnet were withdrawn, at the moment that the intervening distance was 4 fingers'-breadth, the piece of iron followed the magnet." Referring to this singular statement, M. Jamin continues:—In prosecuting my studies I have met a parallel case, but possessing nothing mysterious. I will recall to memory that a bar of steel may be magnetised to saturation by a very energetic current; to one of the halves a southern magnetism may be given, which call *positive*, and which may penetrate to the very core of the bar. Then submit the same bar to an *inverse* current, at first very weak, then increasing, so as to obtain a northern or *negative* magnetism—limited at first to the outer surface, and afterwards penetrating to increasing depths, leaving, however, *positive* layers below it. At the extremity of this bar some of the positive magnetism will penetrate to the outside surface. The observed effect is only the

difference between the actions exerted on the outside by the two superposed magnetisations; for, let the north pole of some other ordinary magnet be now placed at a little distance from the extremity of the magnetised steel, the north pole will be found to act upon its predominating outer and southern layer so as to attract; but on bringing the same extremity nearer the two northern magnetisms (the one on the ordinary magnet, and the other in the core and at the extreme point of the manufactured magnet) act upon each other to the production of a repelling force.

The Quantities of Magnetism and the Situation of the Poles in Slender Needles.—E. Bouty. (Continuation of a former paper.)—The *distance of the poles* from the extremities lessens nearly uniformly as x, the magnetising force increases from zero. The following formula represents this under large limits:—

$$\frac{d}{2} = a\,D\,(1 - p\,x).$$

D = diameter of the needle; d = double the distance of a pole to the nearest extremity; a and p = constants. For very great values of x this formula ceases to be applicable, and d rapidly approaches to a lower limit, $\delta = 2\,a\,D$, which, with the minimum quantity of magnetism L, defines what is called saturation. If we indicate by $\phi(x)$ the permanent magnetising function of the steel employed, the magnetic moment of a needle l long—very great with regard to D—magnetised by a magnetic power x, will be represented by—

$$y = \frac{\omega D^2}{4}\phi(x)\,[l - 2aD(z - p\,x)],$$

whilst, for values of y very close upon its superior limit Y,—

$$Y = \frac{\omega D^2}{4} L(l - 2\,a\,D).$$

Repetition of Passage into the Helix.—Continuing this subject,* he says it was interesting to find out whether the increase of the magnetic moment under consideration proceeded from a simple change in the distribution of the magnetism,—that is to say, from a displacement of the poles towards the extremities; or if there was a true increase of the quantity of permanent magnetism retained by the needle. The result of enquiries are satisfactory, for I have found (he says) that the quantity of magnetism and the situation of the poles change at the same time. If the power of x is made to increase from zero, $\frac{A}{A-B}$, the proportion of the quantity of limit magnetism to the quantity corresponding to the first passage decreases and tends towards zero; but it is remarkable that, by means of the curve to represent the magnetising function, if we look for what ought to be the strength x' of the magnetic force to produce the quantity after a single passage into the helix, we find for the proportion $\frac{x'}{x}$ a very sensible constant.

No. 14. April 12, 1875.

E. Pétion sends a memorandum in which he proposes a new means of preserving wood. He proceeds by first submitting the wood to the prolonged action of smoke, and afterwards covering it with a coating of tar-water or of whitewash.

Les Mondes. Vol. xxxvi., No. 11. March 18, 1875.

A proposition to place clock dials at the corners of the most frequented streets, particularly in those places where public clocks are wanting, is to be shortly laid before the French Municipal Council. These clock-dials are to be similar to, but rather smaller than, those seen at railway stations, &c., and are to be placed in front of gas-burners; the mechanism being in electrical communication with the Bourse, they will all correctly record Bourse time.

Les Mondes. Vol. xxxvi., No. 15. April 15, 1875.

Clamond's Thermo-Electric Battery.—H. Logeman.—A letter detailing some experiments made with a small thermo-electric pile, equal in power to two small Bunsen's couples. The experiments illustrate nothing more than what has been several times set forth in earlier numbers of this Journal.

Annales Telegraphiques. Third Series. Vol. ii. January and February, 1875.

The most important articles are—*The Comparison of Insulators* and *Trials of Brooks's Insulators*, a recapitulation of the researches of various electricians, notably M. Gaugain. The perusal of this article, we are informed, will dispense with the necessity of referring to the previous works of M. Gaugain, as regards the trials of Brooks's insulators.

Amongst other articles we notice a long and cleverly written one on *Electric Vote-recording Machines*. This part contains no fewer than seven large folding plates, in addition to several woodcut illustrations.

The traffic receipts of the Great Northern Telegraph Company for the month of April were—this year, 351,662 frs.; last year, 343,158 frs. Total traffic receipts 1st January to 30th April—this year, 1,235,974 frs.; last year, 1,326,066 frs.

The traffic receipts of the Direct Spanish Telegraph Company, Limited, for the month of April (30 days), 1875, were £1494 14s. 6d., against £1475 3s. in March (31 days).

Magnetic Railway Rails.—M. Heyl, engineer of one of the German railways, in a recent report upon the special section under his charge, calls attention to the development of magnetism in the rails. He says: "I have observed that all the rails are transformed at their extremities, after they have been placed in position a few days, into powerful magnets, capable of attracting and of retaining a key or even a heavier piece of metallic iron. These rails preserve their magnetism even after they have been removed, but they lose it gradually. When in position, however, the magnetism is latent, only becoming free when the chairs are removed, and disappearing again when they are replaced. Hence it is necessary to assume that two opposite poles come together at each junction, and that each rail is a magnet, the poles being alternately reversed throughout the line. This production of magnetism in the rails examined is undoubtedly attributable to the running of the trains, and to the shocks, friction, &c., thereby produced. The hypothesis of electric currents, induced or direct, must be rejected, since it is negatived by experiments upon the subject made with suitable apparatus. Although the interest attaching to the fact above stated is at present purely scientific, it is not impossible, says the *Franklin Journal*, that the magnetism thus developed may exercise an influence actually beneficial upon the stability of the roadway, increasing the adherence to the rails and the friction. It is possible, also, that the magnetic currents may be stronger at the moment of the passage of the trains, than either before or after. If this be so, the observations may acquire a still higher practical importance.

To Correspondents.

"Novice" asks—Why are galvanised iron roofs used on the top of telegraph poles? They are used to keep the damp out of the top of the pole, which would otherwise rot.

* "The Magnetisation of Steel." By E. Bouty (Tel. Journ., vol. ii., p. 211).